

### REMARKS

Applicants appreciate the examination of the present application and the indication that Claims 4-15, 17-19, 22, 39-40 and 43-44 are not rejected under 35 USC §§ 102 or 103. In response to the Official Action, Applicants have amended Claims 1-22, 36, 38, 42 and 46 to address a number of technical rejections under 35 USC §§ 101 and 112. Applicants have also added new computer-program product Claims 52-54 and apparatus Claims 55-56.

The rejections set forth at sections 3-8 of the Official Action will now be addressed in sequence.

#### Claims 20-21 are not duplicates of Claims 1-3

Applicants respectfully submit that independent Claims 1 and 20 are not duplicate claims as argued by the Examiner. For example, Claim 1 recites:

1. A computer-implemented method of modeling a three-dimensional surface of an object, comprising the steps of:
  - generating from an initial triangulation of the surface, a hierarchy of progressively coarser triangulations of the surface by performing a sequence of edge contractions to the initial triangulation;
  - connecting the triangulations in the hierarchy using homeomorphisms; and
  - homeomorphically mapping** edges of a triangulation in the hierarchy back to the initial triangulation.

However, Claim 20 recites a number of significant distinctions relative to Claim 1. In particular, Claim 20, which is reproduced below, recites "converting an initial triangulation ... **into a quadrangulation** ...". This recitation of a "quadrangulation" is not provided within Claim 1. Moreover, unlike Claim 1, Claim 20 does not require that the step of "mapping edges" be necessarily performed as a "homeomorphically mapping" step, as highlighted above. Accordingly, for at least these reasons, Applicants submit that Claims 1 and 20 are sufficiently distinct to be included in one patent.

Claim 20

20. A computer-implemented method of modeling a three-dimensional surface of an object, comprising the step of:  
    converting an initial triangulation of the surface **into a quadrangulation of the surface** that is homeomorphic to the triangulation by:  
        generating from the initial triangulation a hierarchy of progressively coarser triangulations of the surface by performing a sequence of edge contractions to the initial triangulation; and  
        mapping edges of a triangulation in the hierarchy back to the initial triangulation.

Claim 42 has been amended to include multiple "means plus function" recitations

To accord with the Examiner's request, Claim 42 has been amended to include multiple "means" recitations. Accordingly, Claims 42-44 meet the requirements of 35 USC § 112, ¶1.

The claims meet the requirements of 35 USC § 112, ¶2

Applicants respectfully submit that none of the cited independent claims omit any essential steps or elements in violation of MPEP § 2172.01. Instead, Applicants have appropriately used the preamble recitations "comprising" and "comprising the steps of" to define all essential steps or elements of the invention being claimed. Applicants acknowledge that many of the independent claims include recitations directed to respective "subcombinations" of the disclosed embodiments of the invention described throughout the application. But, reciting such subcombinations is entirely appropriate when the preamble language of "comprising" or "comprising the steps of" is used. Accordingly, Applicants submit that 35 USC § 112, ¶2 does not require that all "final" steps or elements of a method or structure be recited when claims directed to a subcombination are presented for examination. Indeed, the intermediate "triangulations" and "quadrangulations", which are recited by the claims, are, in fact, models of a surface as identified by the preambles of the claims.

Applicants further submit that the present assignee's commercially marketed object modeling software, which is covered by the claims of the present application, has independent commercial value and utility even if an end user of the software performs one or more "final" steps in an overall object modeling operation. Thus, requiring Applicants to add such "final" steps or elements to the independent claims would severely limit Applicants' protection for subcombinations of disclosed embodiments of the invention. Instead, these additional steps have been included in many of the dependent claims, which is an appropriate way of covering back-end and final modeling steps.

Based on these remarks, Applicants respectfully request withdrawal of the rejections based on 35 USC § 112, ¶2.

The claims meet the requirements of 35 USC § 101

As requested by the Examiner, the preambles of method claims 1-22 and 46 have been amended to recite a "computer-implemented method of modeling." Nonetheless, Applicants respectfully disagree with the Examiner's assertion that the method steps "recite a process comprising an abstract idea" without any limitation to a practical application. (See, Official Action, p. 6, sections 6.2-6.3). Instead, the practical application of the claimed methods is computer modeling, which includes manipulating data representing points on surfaces of objects to achieve a practical result (e.g., a digital model that may be used in a variety of applications including computer-aided design (CAD) and computer-aided manufacturing (CAM)). From a statutory standpoint, the methods and apparatus claimed herein are analogous to widely patented circuit simulators and circuit simulation methods that utilize purely digital models of circuit elements and the responses of such elements to simulated stimulus. (See, e.g., MPEP § 2106, Guidelines for Patenting Computer-Related Inventions: "[f]or such subject matter to be statutory, the claimed process must be limited to a practical application of the abstract idea or mathematical algorithm in the technological arts." (citing Allapat 33 F.3d at 1543)). As described at pages 13-15 of the application, this

data is not "abstract" data. Instead, the data is derived from scanning physical objects and/or from digital models of three-dimensional shapes that may approximate physical objects. Applicants respectfully submit, therefore, that all claims are statutory under 35 USC § 101.

Claims 1-3, 16, 20-21, 36-38, 42 and 46 are patentable over the cited references

Applicants respectfully submit that all claims are patentable over the cited references because the primary reference used to reject all claims under 35 USC §§ 102, 103, i.e., Dey et al., does not disclose or suggest, among other things, a "hierarchy of triangulations" or the concept of connecting a hierarchy of triangulations using homeomorphisms, as argued by the Examiner. (See, e.g., Official Action, p. 7, section 7.2). In stark contrast to a hierarchy of triangulations described in the present application, Dey et al., which is coauthored by two of the present inventors (Edelsbrunner and Nekhayev), discloses a "hierarchy of complexes". (See, e.g., Dey et al., p. 28). This disclosure of a "hierarchy of complexes" expresses a sequence of more and more complicated local neighborhoods that are possible in a simplicial complex. In Dey et al.,  $M_j$  is a class of complexes for which every local neighborhood has a complication index of at most  $j$ . The hierarchy of the sequence of classes is achieved because  $M_{j+1}$  contains all complexes of  $M_j$  plus additional complexes that are one index more complicated. (See, e.g., Dey et al., p. 28, where the classes are described as forming a nested hierarchy:  $\{0\} = M_{-1} \subset M_0 \subset M_1 \subset M_2 \subset \dots$ ). The discussion of a "hierarchy" in Dey et al. addresses classes of complexes and their abstract relation in terms of indices. However, this discussion in Dey et al. is not descriptive or suggestive of any "hierarchy of triangulations", as explained in the present application, for which an edge contraction is merely an elementary step.

Based on this discussion, Applicants respectfully request that Dey et al. be removed as a primary reference and that all claims be indicated as allowable over the cited prior art references. Applicants also reserve the right to address the deficiencies of the disclosures of the secondary references (e.g., Ramaswami et

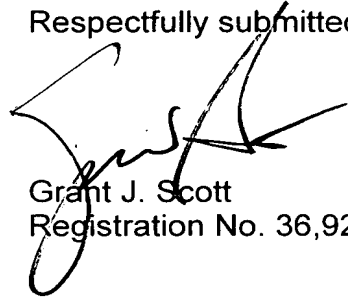
In re: Edelsbrunner et al.  
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al. and Heckbert et al.) in the event a new primary reference is cited by the Examiner.

#### CONCLUSION

Applicants have addressed each of the outstanding technical rejections to the claims and have shown that Dey et al. cannot be sustained as a primary reference. Accordingly, Applicants respectfully requests passing the present application to issuance. The Examiner is also strongly encouraged to contact the undersigned in the event any issues remain which may prevent issuance of the present application.

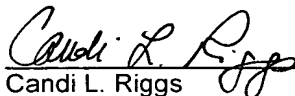
Respectfully submitted,



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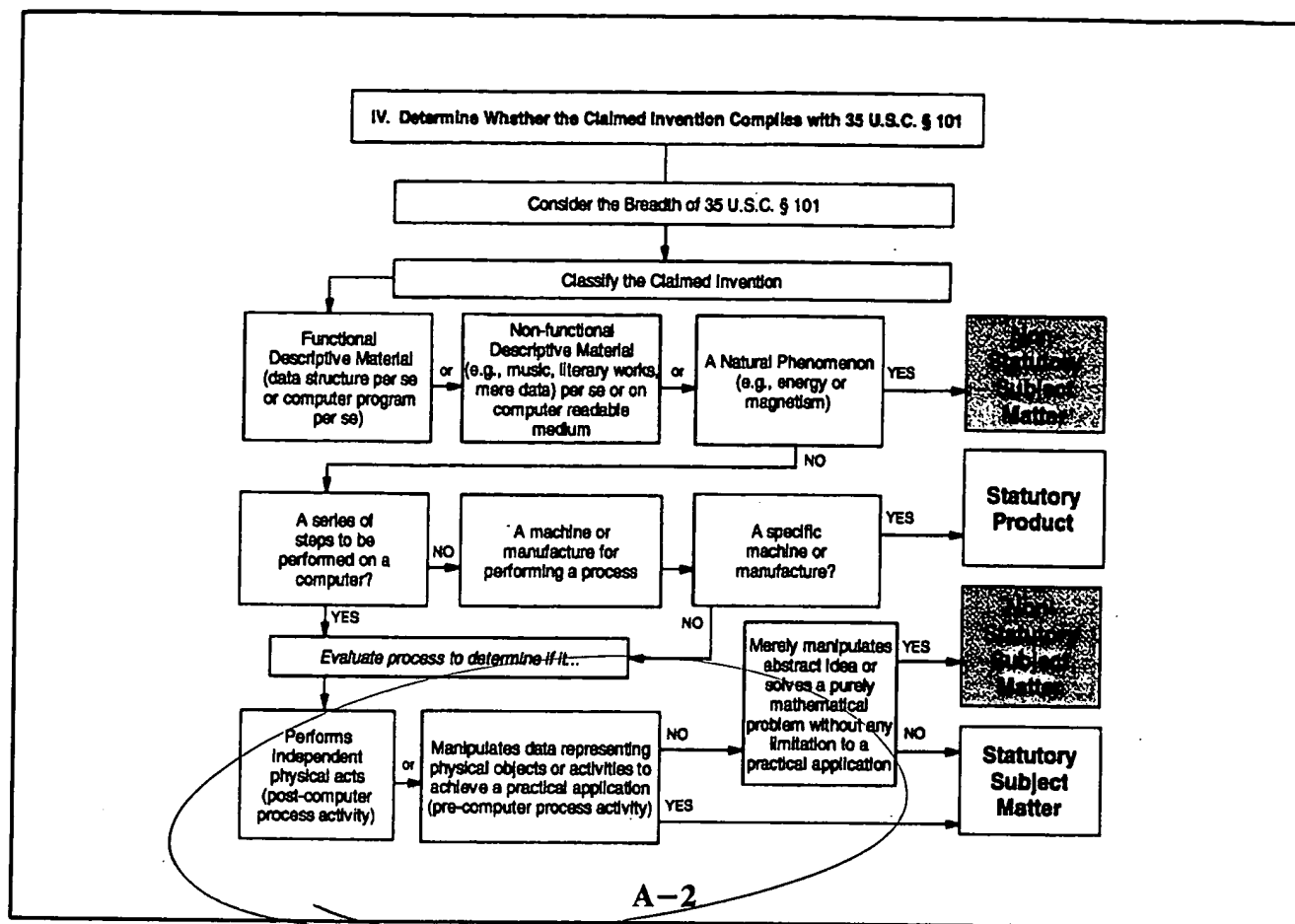
#### **CERTIFICATE OF MAILING**

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Mail Stop Non-Fee Amendment, Commissioner for Patents, Washington, DC 20231, on September 20, 2004.



Candi L. Riggs

Date of Signature: September 20, 2004



## 2106.01 Computer Programming and 35 U.S.C. 112, First Paragraph

The requirements for sufficient disclosure of inventions involving computer programming is the same as for all inventions sought to be patented. Namely, there must be an adequate written description, the original disclosure should be sufficiently enabling to allow one to make and use the invention as claimed, and there must be presentation of a best mode for carrying out the invention.

The following guidelines, while applicable to a wide range of arts, are intended to provide a guide for analyzing 35 U.S.C. 112, first paragraph, issues in applications involving computer programs, software, firmware, or block diagram cases wherein one or more of the "block diagram" elements are at least partially comprised of a computer software component. It should be recognized that sufficiency of disclosure issues in computer cases necessarily will require an inquiry into both the sufficiency of the disclosed hardware as well as the disclosed soft-

ware due to the interrelationship and interdependence of computer hardware and software.

### WRITTEN DESCRIPTION

The function of the description requirement is to ensure that the inventor had possession of, as of the filing date of the application relied on, the specific subject matter later claimed by him or her; how the specification accomplishes this is not material. *In re Herschler*, 591 F.2d 693, 700-01, 200 USPQ 711, 717 (CCPA 1979) and further reiterated in *In re Kaslow*, 707 F.2d 1366, 707 F.2d 1366, 217 USPQ 1089 (Fed. Cir. 1983). See also MPEP § 2163 - § 2163.04.

### BEST MODE

The purpose of the best mode requirement is to "restrain inventors from applying for patents while at the same time concealing from the public the preferred embodiments of their inventions which they have in fact conceived," *In re Gay*, 309 F.2d 769, 772, 135 USPQ 311, 315 (CCPA 1962); "only evidence of concealment